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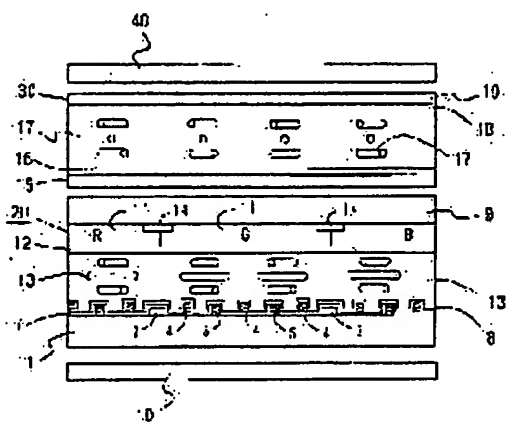
(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a liquid crystal display device having high contrast, wherein satisfactory black display can be obtained.
SOLUTION: The liquid crystal display device is provided with a liquid crystal cell 20 wherein liquid crystal molecules are twist-arranged when no voltage is applied and a lateral electric field is applied when voltage is applied, an optical compensation layer 30 superposed on the liquid crystal cell 20 and polarizing plates 10 and 40 disposed on the outer sides of the liquid crystal cell 20 and the optical compensation layer. When the liquid crystal cell 20 is observed in the normal direction of the liquid crystal cell 20, the direction of the lateral electric field is set to the intermediate direction between the axis directions of the liquid crystal molecules 13 close to respective interfaces of substrates 1 and 9 of the liquid crystal cell 20 and the directions of the transmission axes of the polarizing plates 10 and 40 are set to the directions nearly parallel or nearly orthogonal to the axis directions of liquid crystal molecule 13 and an optical compensation element 17 in the position closest to the polarizing plates 10 and 40, respectively, when no voltage is applied.



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CLAIMS

[Claim(s)]
[Claim 1] The liquid crystal cell which carries out horizontal arrangement along the direction of the horizontal electric field in which enclose liquid crystal between the substrates of a pair and this liquid crystal carries out a twist array at the time of no electrical-potential-difference impressing and, which are generated in this liquid crystal at the time of electrical-potential-difference impression, The optical compensation layer which has an optical compensation component while being arranged in piles at said liquid crystal cell, It has the first polarizing plate arranged on the outside of a liquid crystal cell, and the second polarizing plate arranged on the outside of an optical compensation layer. When it observes from [of the substrate of said liquid crystal cell] a normal, the direction of the horizontal electric field generated at the time of electrical-potential-difference impression is set up in the in-between direction of the shaft orientations of the liquid crystal molecule in the liquid crystal cell nearest to the first polarizing plate, and the shaft orientations of the liquid crystal molecule in the liquid crystal cell nearest to the second substrate. The transparency shaft of the first polarizing plate is set as the shaft orientations of the liquid crystal molecule in the liquid crystal cell nearest to the first polarizing plate at the time of no electrical-potential-difference impressing in the direction which it is abbreviation-parallel or intersects [abbreviation] perpendicularly. The transparency shaft of the second polarizing plate is a liquid crystal display characterized by being set as the shaft orientations of the optical compensation component in the optical compensation layer nearest to the second polarizing plate at the time of no electrical-potential-difference impressing in the direction which it is abbreviation-parallel or intersects [abbreviation] perpendicularly.
[Claim 2] The liquid crystal display according to claim 1 characterized by setting the twist direction of said optical compensation component as the twist direction and hard flow of a liquid crystal molecule in said liquid crystal cell while an optical compensation component carries out a twist array within said optical compensation layer.
[Claim 3] The liquid crystal display according to claim 1 to 2 which the twist angle of the liquid crystal molecule of said liquid crystal cell and the twist angle of the optical compensation component of said optical compensation layer are in abbreviation etc. by carrying out, and is characterized by things.
[Claim 4] The liquid crystal display according to claim 1 to 3 characterized by the shaft orientations of the liquid crystal molecule in the liquid crystal cell nearest to said optical compensation layer and the shaft orientations of the optical compensation component in said

optical compensation layer nearest to said liquid crystal being in orthogonality relation mutually.
[Claim 5] Liquid crystal is a liquid crystal display according to claim 1 to 4 characterized by adding chiral material while having a forward dielectric constant anisotropy.
[Claim 6] The liquid crystal display according to claim 1 to 5 characterized by a display mode being a normally black.
[Claim 7] The liquid crystal display according to claim 1 to 6 characterized by arranging a pixel electrode and a common electrode on one substrate of said liquid crystal cell, and horizontal electric field occurring between said pixel electrodes and said common electrodes at the time of electrical-potential-difference impression.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the liquid crystal display which realized high contrast on the wide-field-of-view square.
[0002]
[Description of the Prior Art] Although TN method was put in practical use in the liquid crystal display, TN method had the problem that an angle of visibility was narrow. Then, the method which was excellent in viewing-angle properties, such as an IPS method and VA method, is proposed. The general gestalt of an IPS method pinched liquid crystal with the substrate of a pair, and arranges the pixel electrode and the common electrode to one substrate. The pixel electrode and the common electrode are carrying out the ctenidium-like configuration, respectively, and the ctenidium part of a pixel electrode and the ctenidium part of a common electrode are arranged almost in parallel within the pixel. The laminating of the orientation film which carried out level orientation in the abbreviation rectangular cross direction of the direction of horizontal electric field is carried out to both substrates, and a liquid crystal molecule carries out horizontal arrangement of the time of no electrical-potential-difference impressing along the direction of orientation of the orientation film. And at the time of electrical-potential-difference impression, a liquid crystal molecule rotates in accordance with the horizontal electric field generated between a pixel electrode and a common electrode, and permeability is controlled by change of this array condition.
[0003] However, there is a problem that a speed of response is slow in an IPS method, and various amelioration is tried in order to improve this. There is an IPS mold liquid crystal display indicated by JP,10-73823,A as the example, and the gestalt is explained based on a drawing. In addition, the case in the normally black mode equipped with the optical compensation layer here is explained.
[0004] Drawing 7 is the mimetic diagram showing the array condition of the liquid crystal molecule at the time of no electrical-potential-difference impressing, and drawing 8 is the mimetic diagram showing the array condition of the liquid crystal molecule at the time of

electrical-potential-difference impression. For 100, a liquid crystal cell and 101 is [the second polarizing plate 103 by the side of incident light of an optical compensation layer and 102] the second polarizing plate by the side of an observer. The pneumatic liquid crystal 104 in which a liquid crystal cell 100 has a forward dielectric constant anisotropy between the substrates of a pair is pinched, and chiral material is added by this liquid crystal 104. Ctenidium-like the pixel electrode and common electrode which are not illustrated are formed in a lower substrate, and the ctenidium-like part of two electrodes is arranged in parallel within each pixel. The laminating of the orientation film with which level orientation processing was performed is carried out to a top substrate and a bottom substrate, and horizontal arrangement of the liquid crystal molecule 104 of a substrate interface is carried out along this direction of orientation. Drawing 9 (a) shows the relation between the direction of orientation at the time of observing from [of a substrate] a normal, and the direction of electric field. In the direction of orientation of the orientation film of a bottom substrate, and a continuous line 20, the direction of orientation of the orientation film of a top substrate and a dotted line 10 show the transparency shaft of the first polarizing plate 102, and, as for an alternate long and short dash line 10, a dotted line 20 shows [the direction of electric field at the time of electrical-potential-difference impression, and a continuous line 10] the transparency shaft of the second polarizing plate 103, respectively. When the direction of electric field (alternate long and short dash line 10) was set as 0 times here, a counterclockwise rotation is specified in the forward direction and a clockwise rotation is specified in the negative direction, the direction of orientation of a top substrate (continuous line 20) is set as 45 degrees for the direction of orientation of a bottom substrate (continuous line 10) -45 degrees. In order for the liquid crystal molecule 104 to be influenced by the orientation film at the time of no electrical-potential-difference impressing and to arrange, it turns [direction / of a major axis / of the liquid crystal molecule 104 of a bottom substrate interface] to a continuous line 10, and turns [direction / of a major axis / of the liquid crystal molecule 104 of a top substrate interface] to a continuous line 20, horizontal arrangement is carried out, and horizontal arrangement is carried out within the liquid crystal cell 100, being counterclockwise twisted from a bottom substrate 90 degrees to a top substrate. The transparency shaft (dotted line 10) of the first polarizing plate 102 is set up in the same direction as the direction of electric field (alternate long and short dash line 10), and the transparency shaft (dotted line 20) of the second polarizing plate 103 is set up in the rectangular direction of the transparency shaft (dotted line 10) of the first polarizing plate 102. Therefore, each transparency shaft shifts from the liquid crystal molecule 104 of a substrate interface 45 degrees, and is arranged.

[0005] The liquid crystal for compensation is pinched by the substrate of a pair, and, as for the optical compensation layer 101, the laminating of the orientation film with which level orientation processing was performed, respectively is carried out to both substrates. The relation between the direction of orientation of this orientation film and the direction of electric field at the time of electric-field impression is shown in drawing 9 (b). A continuous line 30 shows the direction of orientation of a bottom substrate, a continuous line 40 shows the direction of orientation of a top substrate, respectively, and the direction of orientation of a top substrate (continuous line 40) is set as 45 degrees for the direction of orientation of a bottom substrate (continuous line 30) 135 degrees. The major axis carries out horizontal arrangement toward the direction of orientation of a bottom substrate (continuous line 30), the major axis carries out horizontal arrangement of the liquid crystal molecule 105 of a bottom substrate interface toward the direction of orientation of a top substrate (continuous line 40), and within the optical compensation layer 101, while the liquid crystal molecule 105 is clockwise twisted from a bottom substrate 90 degrees to a top substrate, it is carrying out horizontal arrangement of the liquid crystal molecule 105 of a top substrate interface. Therefore, the transparency shaft (dotted lines 10 and 20) of each first polarizing plate 102 and 103 shifts from the liquid crystal molecule 105 of a substrate interface 45 degrees, and is arranged.

[0006] In the case of normally black mode, it sets up so that the retardation of a liquid crystal cell 100 may be completely offset according to the retardation of the optical compensation layer 101. The amplitude direction of the transmitted light at the time of observing from [of the

substrate in a corresponding location] a normal is shown in the right-hand side of drawing 7 and drawing 8 . Although the transmitted light which passed the first polarizing plate 102 is the linearly polarized light which carries out the amplitude to a direction 0 times, when a birefringence is carried out with liquid crystal 104 and a liquid crystal cell 100 is passed, it becomes elliptically polarized light. Although the birefringence of this transmitted light is carried out with the liquid crystal 105 for compensation, since the retardation of the optical compensation layer 101 is set up so that the retardation of a liquid crystal cell 100 may be offset, the transmitted light which passed the optical compensation layer 101 turns into the linearly polarized light which carries out the amplitude to a direction 0 times again, and is shaded with the second polarizing plate 103.
[0007] As shown in drawing 8 , the liquid crystal molecule 104 of a liquid crystal cell 100 rotates and carries out horizontal arrangement of the time of electrical-potential-difference impression in the direction of electric field (alternate long and short dash line 10). At this time, the array condition of the liquid crystal 105 for compensation of the optical compensation layer 101 does not change. Since the direction of a major axis of the liquid crystal molecule 104 and the transparency shaft orientations (dotted line 10) of the first polarizing plate 102 become in the same direction, the transmitted light of the linearly polarized light which passed the first polarizing plate 102 here passes a liquid crystal cell 100 with the linearly polarized light which carries out the amplitude to a direction 0 times. And when the birefringence of this transmitted light is carried out and the optical compensation layer 101 is passed with the liquid crystal 105 for compensation of the optical compensation layer 101, it turns into elliptically polarized light, and it passes the transparency shaft of the second polarizing plate 103.
[0008]
[Problem(s) to be Solved by the Invention] However, in the case of the above-mentioned liquid crystal display, since the shaft orientations of the liquid crystal molecule of a substrate interface and the transparency shaft orientations of a polarizing plate have shifted 45 degrees in the case of a black display, it is easy to produce the optical leakage at the time of a black display, and the good black display was hard to be obtained. Then, as a result of inquiring by paying one's attention especially about the relation between the shaft orientations of the liquid crystal molecule of a substrate interface, and the transparency shaft orientations of a polarizing plate, it came to invent the liquid crystal display with which a good black display is obtained.
[0009] that is, the black display with good this invention -- it can carry out -- high -- it aims at offering a contrast liquid crystal display.
[0010]
[Means for Solving the Problem] The liquid crystal cell which carries out horizontal arrangement along the direction of the horizontal electric field in which this invention encloses liquid crystal between the substrates of a pair in order to solve the above-mentioned technical problem, and this liquid crystal carries out a twist array at the time of no electrical-potential-difference impressing and, which are generated in this liquid crystal at the time of electrical-potential-difference impression, The optical compensation layer which has an optical compensation component while being arranged in piles at said liquid crystal cell, It has the first polarizing plate arranged on the outside of a liquid crystal cell, and the second polarizing plate arranged on the outside of an optical compensation layer. When it observes from [of the substrate of said liquid crystal cell] a normal, the direction of the horizontal electric field generated at the time of electrical-potential-difference impression is set up in the in-between direction of the shaft orientations of the liquid crystal molecule in the liquid crystal cell nearest to the first polarizing plate, and the shaft orientations of the liquid crystal molecule in the liquid crystal cell nearest to the second substrate. The transparency shaft of the first polarizing plate is set as the shaft orientations of the liquid crystal molecule in the liquid crystal cell nearest to the first polarizing plate at the time of no electrical-potential-difference impressing in the direction which it is abbreviation-parallel or intersects [abbreviation] perpendicularly. It is characterized by setting the transparency shaft of the second polarizing plate as the shaft orientations of the optical compensation component in the optical compensation layer nearest to the second polarizing plate at the time of no electrical-potential-difference impressing in the direction which it is

abbreviation-parallel or intersects [abbreviation] perpendicularly. Therefore, the liquid crystal display with which the response time is short and a good black display is obtained is realizable.
[0011]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained based on drawing. Drawing 1 shows the outline cross section of a liquid crystal display, and drawing 2 shows the outline top view by the side of the first substrate of a liquid crystal display. With this operation gestalt, the first polarizing plate 10, a liquid crystal cell 20, the optical compensation layer 30, and the second polarizing plate 40 are piled up one by one.
[0012] In the liquid crystal cell 20, liquid crystal 13 is pinched between the substrate 1 of a pair, and 9. 1 is the first transparent substrate, such as a glass substrate, and two or more scanning lines 2 and two or more signal lines 3 are arranged in the shape of a matrix. TFT4 (thin film transistor) which is a switching element is arranged at the intersection of the scanning line 2 and a signal line 3, and the ctenidium-like pixel electrode 5 is arranged in 1 pixel surrounded with the scanning line 2 and a signal line 3. TFT4 -- a source electrode is connected to a signal line 3, and the drain electrode is connected to the pixel electrode 5 for the gate electrode at the scanning line 2, respectively. 6 is the common electrode of the shape of a ctenidium formed ranging over two or more pixels, is formed on a protective coat 7 and insulated with the signal line 3 by part for the intersection. Within each pixel, the ctenidium parts of the pixel electrode 5 and the common electrode 6 are arranged in parallel, and when an electrical potential difference is impressed to the pixel electrode 5, horizontal electric field occur between the pixel electrode 5 and the common electrode 6. Although the number of the ctenidium electrode arranged in 1 pixel is become to two with the pixel electrode 5 and has become three with the common electrode 6 with this operation gestalt, this invention is not limited to this number. 8 is the orientation film by which the laminating was carried out on the first substrate 1, and level orientation processing is performed in the direction mentioned later.
[0013] 9 is the second transparent substrate by which opposite arrangement was carried out at the first substrate 1, and the grid-like light-shielding film 14 is formed in a signal line 2, the scanning line 3, and the location that counters. 11 is a color filter arranged according to each pixel, and one coloring layer of R, G, and B is arranged in the shape of a stripe for every pixel. 12 is the orientation film by which the laminating was carried out on the color filter 11, and level orientation processing is performed in the direction mentioned later.
[0014] 13 is a pneumatic liquid crystal which has a forward dielectric constant anisotropy, and chiral material is added. Therefore, at the time of no electrical-potential-difference impressing, horizontal arrangement of a substrate 1 and the liquid crystal molecule 13 of nine interfaces is carried out in the direction of orientation of the orientation film 8 and 12, and horizontal arrangement is carried out between a substrate 1 and 9, being twisted. With this operation gestalt, the twist direction of the liquid crystal molecule 13 is counterclockwise rotated to the direction of the first substrate 1 to the second substrate 9, when it observes from [of substrates 1 and 9] a normal.
[0015] The liquid crystal 17 for compensation whose optical compensation layer 30 is an optical compensation component between the substrate 15 of a pair and 19 is pinched. 15 and 19 are transparent substrates and the laminating of the orientation film 16 and 18 with which level orientation processing was performed in the direction mentioned later, respectively is carried out. Chiral material is added by the liquid crystal 17 for compensation pinched by these substrates 15 and 19, and horizontal arrangement of a substrate 15 and the liquid crystal molecule 17 for compensation of 19 interfaces is carried out along the direction of orientation of the orientation film 16 and 18, and they carry out horizontal arrangement of a substrate 15 and the liquid crystal molecule 17 for compensation between 19, being twisted. This twist direction turns into the liquid crystal 13 and hard flow of a liquid crystal cell 20, and when it observes from [of substrates 15 and 19] a normal, it is clockwise rotated to the direction of a substrate 15 to the substrate 19.
[0016] The second polarizing plate 40 is arranged on the outside of the first polarizing plate 10 and the substrate 19 of the optical compensation layer 30 at the outside of the first substrate 1 of a liquid crystal cell 20, respectively. Arrangement relation with the direction of orientation of

the transparency shaft of each polarizing plates 10 and 40, a liquid crystal cell 20, and the optical compensation layer 30 is shown in drawing 3 . Drawing 3 is transparency shaft orientations and the direction of orientation of [at the time of observing from / of a substrate 19 / a normal], drawing 3 (a) shows the direction of orientation of a liquid crystal cell 20, and the relation of a transparency shaft, and drawing 3 (b) shows the direction of orientation of the optical compensation layer 30, and the relation of a transparency shaft. As for the direction of orientation of the orientation film 8 of the first substrate 1, and a continuous line 2, a continuous line 1 shows the direction of orientation of the orientation film 12 of the second substrate 9, and the direction of horizontal electric field where the transparency shaft orientations of the first polarizing plate 10 and a dotted line 2 are produced in the transparency shaft orientations of the second substrate 9, and a dotted line 1 produces an alternate long and short dash line 1 at the time of electrical-potential-difference impression. Moreover, a continuous line 3 shows the direction of orientation of the orientation film 16 of a substrate 15, and a continuous line 4 shows the direction of orientation of the orientation film 18 of a substrate 19. In addition, in drawing 3 , the direction of electric field at the time of electrical-potential-difference impression (alternate long and short dash line 1) is set as a direction 0 times, a counterclockwise rotation is made into the forward direction and a clockwise rotation is made into the negative direction.

[0017] In a liquid crystal cell 20, the direction of orientation of the first substrate 1 (continuous line 1) is set as -45 degrees, and the direction of orientation of the second substrate 9 (continuous line 2) is set as 45 degrees. In order to influence a substrate 1 and the liquid crystal molecule 13 of nine interfaces in the direction of orientation of the orientation film 8 and 12 and to arrange at the time of no electrical-potential-difference impressing, As for the liquid crystal molecule 13 of first substrate 1 interface, the direction of a major axis becomes in the same direction as a continuous line 1. The direction of a major axis becomes in the same direction as a continuous line 2, and the liquid crystal molecule 13 of second substrate 9 interface carries out horizontal arrangement of a substrate 1 and the liquid crystal molecule 13 between nine, while the direction of a major axis is counterclockwise twisted from the first substrate 1 90 degrees from a continuous line 1 to a continuous line 2 to the second substrate 9. And at the time of electrical-potential-difference impression, electric field occur in a direction 0 times, and each liquid crystal molecule 17 rotates in a direction 0 times. Since the direction of electric field is set up in the in-between direction (0 times) to the twist direction (45 degrees, -45 degrees) of a substrate 1 and the liquid crystal molecule 17 of nine interfaces at this time, the response time becomes short that a substrate 1 and the liquid crystal molecule 17 of nine interfaces should just be twisted 45 degrees, respectively. The transparency shaft (dotted line 1) of the first polarizing plate 10 is set up in the same direction as the direction of orientation of the first substrate 1 (continuous line 1), and the transparency shaft of both the polarizing plates 10 and 40 lies at right angles.

[0018] In the optical compensation layer 30, the direction of orientation of a substrate 15 (continuous line 3) is set as 135 degrees, and the direction of orientation of a substrate 19 (continuous line 4) is set as 45 degrees. And in order that a substrate 15 and the liquid crystal molecule 17 for compensation of 19 interfaces may carry out horizontal arrangement in the direction of orientation of the orientation film 16 and 18, As for the liquid crystal molecule 17 for compensation of substrate 15 interface, the direction of a major axis becomes in the same direction as a continuous line 3. The direction of a major axis becomes in the same direction as a continuous line 4, and the liquid crystal molecule 17 for compensation of substrate 19 interface carries out horizontal arrangement of a substrate 15 and the liquid crystal molecule 17 between 19, while the direction of a major axis is clockwise twisted from a substrate 15 90 degrees from a continuous line 3 to a continuous line 4 to a substrate 19. The liquid crystal molecule 17 for compensation of the optical compensation layer 30 will return the polarization condition of the transmitted light that the twist direction of the liquid crystal molecule 13 of a liquid crystal cell 20 is twisted the degree of the same angle, and the rotatory polarization was carried out to hard flow by the liquid crystal cell 20 to the condition before passing a liquid crystal cell 20 by the optical compensation layer 30. The transparency shaft (dotted line 2) of the second polarizing plate 40 is set up in the same direction as the direction of orientation of a substrate 19

(continuous line 4). With this operation gestalt, since the liquid crystal molecule 13 and the liquid crystal 17 for compensation are twisted 90 degrees, respectively and the transparency shaft of both the polarizing plates 10 and 40 intersects perpendicularly, a continuous line 1 and a continuous line 3 become in the same direction as the transparency shaft (dotted line 1) of the first polarizing plate 10, and a continuous line 2 and a continuous line 4 become in the same direction as the transparency shaft (dotted line 2) of the second polarizing plate 40. However, this invention sets up the transparency shaft of each polarizing plate 10 and 40 in the shaft orientations of a substrate 1 and the liquid crystal molecule of 19 interfaces, the parallel, or the rectangular direction which counters, and the transparency shaft of the first polarizing plate 10 at least is set up in the direction of orientation, the parallel direction, or the rectangular direction of the first substrate 1 of a liquid crystal cell 20, therefore the transparency shaft of the second polarizing plate 40 is set up in the direction of orientation, the parallel direction, or the rectangular direction of a substrate 19 of the optical compensation layer 30.

[0019] Although a continuous line 1, a continuous line 3 and a continuous line 2, and a continuous line 4 become in the same direction in drawing 3 , respectively, the sense of an arrow head is reverse mutually. In this, substrates 1, 9, and 15 and the liquid crystal molecules 13 and 17 of 19 interfaces have a tilt angle, horizontal arrangement is carried out, and the sense of this arrow head shows the inclination direction of the liquid crystal molecules 13 and 17 produced with a tilt angle. Therefore, for the liquid crystal molecule 13 suitable for a continuous line 1, the liquid crystal molecule 17 for compensation suitable for a continuous line 3 and the liquid crystal molecule 13 suitable for a continuous line 2, and the liquid crystal molecule 19 for compensation suitable for a continuous line 4, the inclination direction is reverse ** mutually, respectively.

[0020] Actuation of this liquid crystal display is explained based on drawing 4 and drawing 5 . The mimetic diagram in which drawing 4 shows array conditions, such as the liquid crystal molecule 13 at the time of no electrical-potential-difference impressing, and drawing 5 are the mimetic diagrams showing array conditions, such as the liquid crystal molecule 13 at the time of electrical-potential-difference impression. In addition, drawing 4 and drawing 5 show the amplitude direction of the transmitted light at the time of observing from [of the substrate in the location corresponding to right-hand side] a normal, respectively.

[0021] Based on drawing 4 , the actuation at the time of no electrical-potential-difference impressing is explained first. The transmitted light which passed the first polarizing plate 10 turns into the linearly polarized light which carries out the amplitude in the direction of -45 degrees. In a liquid crystal cell 20, the transmitted light to which the direction of a major axis of the liquid crystal molecule 13 of first substrate 1 interface (continuous line 1 of drawing 3) passed the liquid crystal cell 20 since the liquid crystal molecule 13 was counterclockwise twisted 90 degrees within a liquid crystal cell 20 in accordance with the transparency shaft (dotted line 1 of drawing 3) of the first polarizing plate 10 turns into the linearly polarized light which the rotatory polarization is carried out with the liquid crystal molecule 13, and carries out the amplitude to a direction 45 degrees. Since the mutual direction of a major axis (a continuous line 2 and continuous line 3) intersects perpendicularly, the amplitude direction of the liquid crystal molecule [the liquid crystal molecule 13 of second substrate 9 interface of a liquid crystal cell 20 and] 17 of substrate 15 interface of the optical compensation layer 30 for compensation of the transmitted light corresponds with the direction of a minor axis of the liquid crystal molecule 17 for compensation of substrate 15 interface. And since the liquid crystal molecule 17 for compensation is twisted 90 degrees to the liquid crystal 13 and hard flow of a liquid crystal cell 20 within the optical compensation layer 30, in the case of a liquid crystal cell 20, the rotatory polarization of the transmitted light which passes the optical compensation layer 30 is carried out to hard flow, and it becomes the linearly polarized light which carries out the amplitude in the same direction as the transmitted light which passed the first polarizing plate 10. Therefore, since the transparency shaft of the amplitude direction of the transmitted light which passed the optical compensation layer 30, and the second polarizing plate 40 intersects perpendicularly, it is shaded by the second polarizing plate 40 and the transmitted light becomes a black display.

[0022] Next, based on drawing 5 , the actuation at the time of electrical-potential-difference impression is explained. If an electrical potential difference is impressed to the pixel electrode 5,

horizontal electric field will arise between the pixel electrode 5 and the common electrode 6, the liquid crystal molecule 13 of a liquid crystal cell 20 rotates so that a major axis may be in agreement with the direction of electric field, and an array condition changes. Horizontal arrangement is carried out so that the liquid crystal molecule 13 which the liquid crystal molecule 13 which met the continuous line 1 since electric field (alternate long and short dash line 1) were generated in the direction of 0 times as shown in drawing 3 rotated 45 degrees counterclockwise, and met the continuous line 2 may rotate 45 degrees clockwise and, as for the liquid crystal molecule 13 of 20 in a liquid crystal cell, the direction of a major axis may become in the direction of 0 times. At this time, a substrate 1 and the liquid crystal molecule 13 of nine interfaces will only be twisted 45 degrees, respectively, a substrate 1 and the liquid crystal molecule 13 twisted 90 degrees among nine will be suitable in the same direction, and the response time becomes short. As for the liquid crystal 17 for compensation of the optical compensation layer 30, the array condition does not change at the time of electrical-potential-difference impression, either. Although the transmitted light which passed the first polarizing plate 10 is the linearly polarized light which carries out the amplitude to a direction -45 degrees, when passing a liquid crystal cell 20, with the liquid crystal molecule 13, the birefringence of it is carried out and it turns into elliptically polarized light. Furthermore, when passing the optical compensation layer 30, the birefringence of the transmitted light is carried out with the liquid crystal molecule 17 for compensation, and when reaching the second polarizing plate 40, it will be in the condition of the linearly polarized light which carries out the amplitude in the different direction from not the linearly polarized light that carries out the amplitude in the same direction as the transmitted light of the origin which passed the first polarizing plate 10 but elliptically polarized light, or the original transmitted light. Therefore, the transmitted light passes the second polarizing plate 40, and becomes a white display.

[0023] The liquid crystal display of this invention has less optical leakage at the time of a black display than the liquid crystal display of the conventional example, and can obtain a good black display. Based on drawing 6 , the principle is explained from this. This invention inquired paying attention to the shaft orientations of the liquid crystal molecules 13 and 17 located in the interface of the transparency shaft of polarizing plates 10 and 40, polarizing plates 10 and 40, and the substrates 1 and 19 that counter. Although the liquid crystal molecule 13,104 is twisted 90 degrees within the liquid crystal cell 20,100 when the effect of optical rotatory dispersion is disregarded, what solved 90 twists on the basis of the liquid crystal molecule 13,104 located in the interface of the first polarizing plate 10,102 and the first substrate 1 which counters in this can be typically permuted as a liquid crystal cell. Although the optical compensation layer 30,101 was considered the same way and the liquid crystal molecule 17,105 for compensation is twisted 90 degrees within the optical compensation layer 30,101, let typically what solved 90 twists on the basis of the liquid crystal molecule 17,105 for compensation located in the interface of the second polarizing plate 40,103 and the substrate 19 which counters in this be an optical compensation layer. About the transparency shaft-configuration relation between the direction of a major axis of the liquid crystal molecules 13 and 17,104,105 at this time, and polarizing plates 10 and 40,102,103, the case of this invention is shown in drawing 6 (a), and the case of the conventional example is shown in drawing 6 (b). Although the transparency shaft of the direction of a major axis of the liquid crystal molecules 13 and 17 and polarizing plates 10 and 40 is in agreement in this invention, respectively, the transparency shaft of the direction of a major axis of the liquid crystal molecules 104 and 105 and the first polarizing plate 102 and 103 will shift 45 degrees in the conventional example. Therefore, in the conventional example, although the optical leakage by form birefringence is not generated in this invention, when variation arises in the retardation of a liquid crystal cell 100 and the optical compensation layer 101, the optical leakage by form birefringence occurs. It is difficult to form the optical compensation layer 101 which has the retardation which offsets the retardation of a liquid crystal cell 100 completely by the variation on manufacture etc., and it difficult to prevent the optical leakage which originates in the variation in this retardation in the conventional example. however -- since the optical leakage by form birefringence does not occur in the case of this invention -- a black display better than the conventional example -- it can obtain -- high -- a contrast liquid crystal display

can be obtained. Although the effect of optical rotatory dispersion was disregarded in this explanation, when the effect of optical rotatory dispersion is taken into consideration, the optical leakage by optical rotatory dispersion occurs for the gestalt of this invention, and the conventional example. Therefore, in the conventional example, optical rotatory dispersion and form birefringence will influence the optical leakage at the time of a black display by optical rotatory dispersion influencing in the case of this invention, and the black display with better this invention is obtained.

[0024] In addition, if it is the range which does not deviate from the summary of this invention, gestalten other than the above-mentioned operation gestalt are also possible. For example, a common electrode is prepared in the second substrate side, and you may make it generate slanting electric field between a pixel electrode and a common electrode. Moreover, although regulated in this operation gestalt in the direction of orientation of the orientation film which carried out the laminating of the array of the liquid crystal molecule in an optical compensation layer to the substrate, the array direction may be regulated by the configuration of those other than the orientation film.

[0025]

[Effect of the Invention] When it observes from [of the substrate of a liquid crystal cell] a normal according to this invention, the direction of horizontal electric field is set up in the in-between direction of the shaft orientations of the liquid crystal molecule located in both the substrates interface in a liquid crystal cell. The transparency shaft of the first polarizing plate is set as the shaft orientations of the liquid crystal molecule located in the first polarizing plate side at the time of no electrical-potential-difference impressing in the direction which it is abbreviation-parallel or intersects [abbreviation] perpendicularly. since the transparency shaft of the second polarizing plate is set as the shaft orientations of the optical compensation component located in the second polarizing plate side at the time of no electrical-potential-difference impressing in the direction which it is abbreviation-parallel or intersects [abbreviation] perpendicularly -- the response time -- short -- extensive -- it becomes an angle of visibility liquid crystal display. Moreover, little good black display of optical leakage can be obtained, and high contrast can be realized.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a cross-section schematic diagram at the time of no electrical-potential-difference impressing the liquid crystal display which is the operation gestalt of this invention.

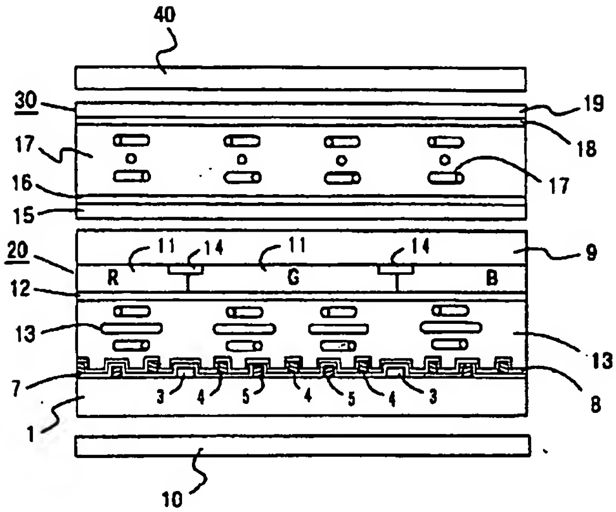
[Drawing 2] It is a flat-surface schematic diagram by the side of the first substrate of the liquid crystal display which is the operation gestalt of this invention.

[Drawing 3] It is drawing showing the transparency shaft-configuration relation between the direction of orientation of the substrate of the liquid crystal cell in the operation gestalt of this invention, and an optical compensation layer, and a polarizing plate.

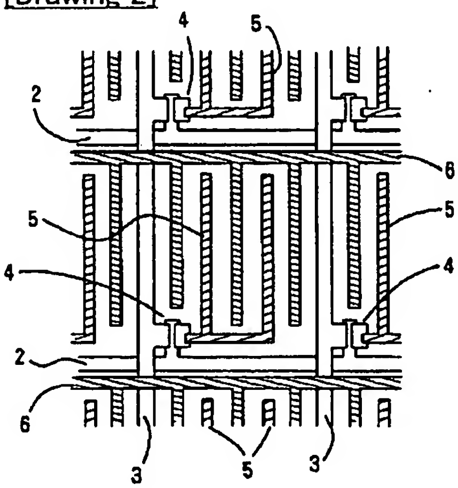
[Drawing 4] It is drawing explaining actuation of the liquid crystal cell at the time of no electrical-potential-difference impressing in the operation gestalt of this invention, and an optical compensation layer.
[Drawing 5] It is drawing explaining actuation of the liquid crystal cell at the time of the electrical-potential-difference impression in the operation gestalt of this invention, and an optical compensation layer.
[Drawing 6] It is the comparison Fig. of the transparency shaft of the polarizing plate at the time of no electrical-potential-difference impressing, the operation gestalt of this invention about the array condition of a liquid crystal molecule, and the conventional example.
[Drawing 7] It is drawing explaining actuation of the liquid crystal cell at the time of no electrical-potential-difference impressing in the conventional liquid crystal display, and an optical compensation layer.
[Drawing 8] It is drawing explaining actuation of the liquid crystal cell at the time of the electrical-potential-difference impression in the conventional liquid crystal display, and an optical compensation layer.
[Drawing 9] It is drawing showing the transparency shaft-configuration relation between the direction of orientation of the substrate of the liquid crystal cell in the conventional liquid crystal display, and an optical compensation layer, and a polarizing plate.
[Description of Notations]
1 First Substrate
8, 12, 16, 18 Orientation film
9 Second Substrate
10 First Polarizing Plate
13 Liquid Crystal Molecule
15 19 Substrate
17 Liquid Crystal Molecule for Compensation
20 Liquid Crystal Cell
30 Optical Compensation Layer
40 Second Polarizing Plate

DRAWINGS

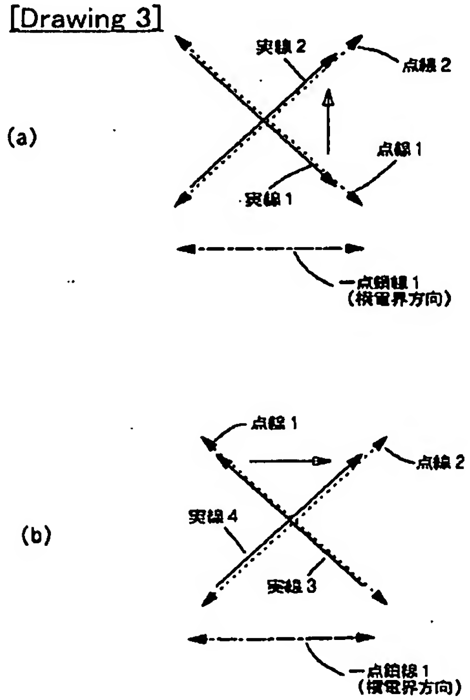
[Drawing 1]



[Drawing 2]



[Drawing 3]



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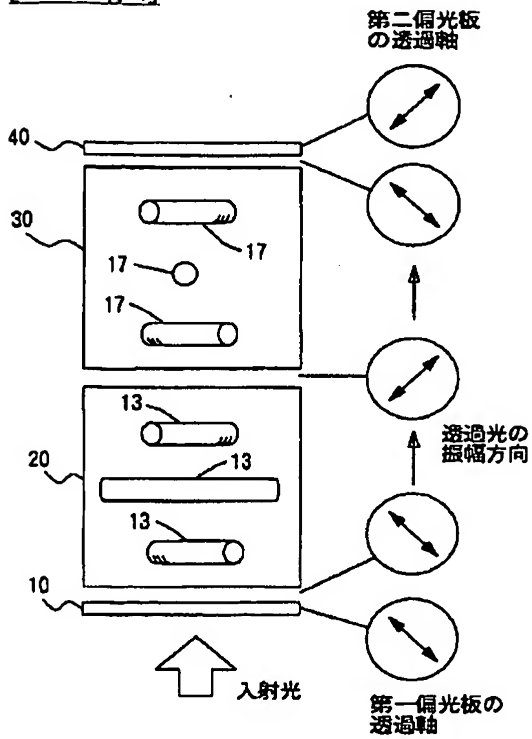

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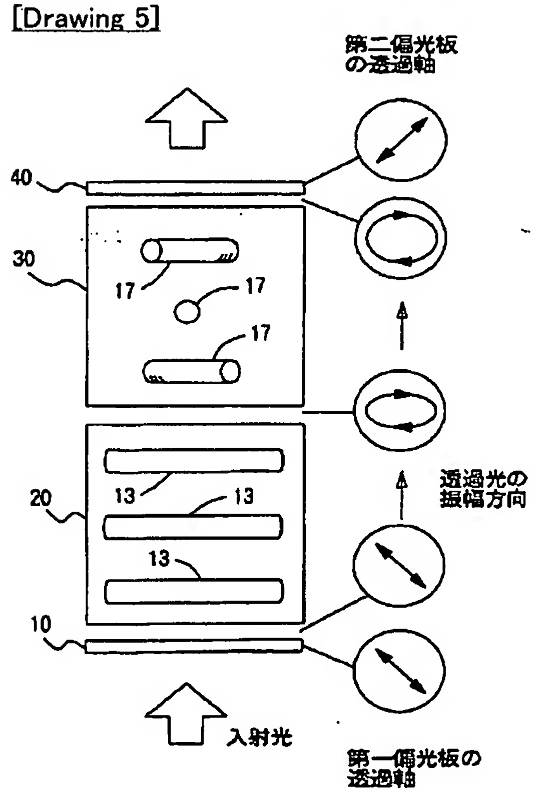

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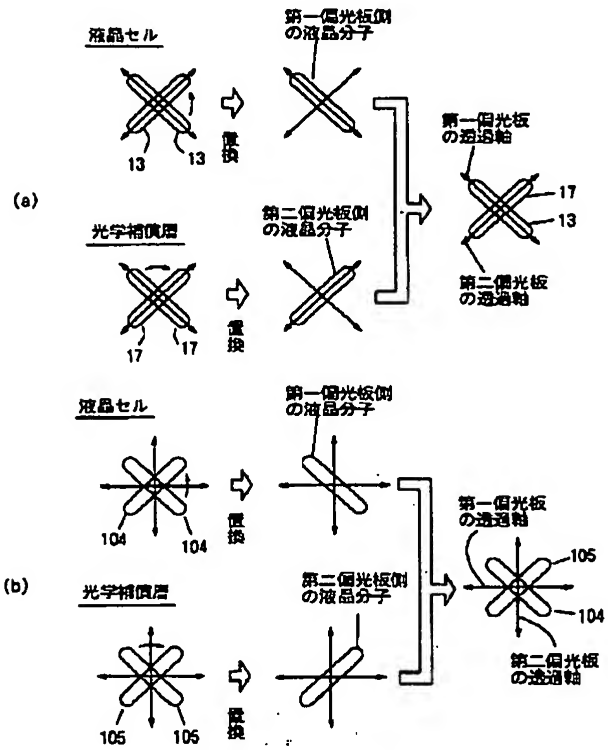

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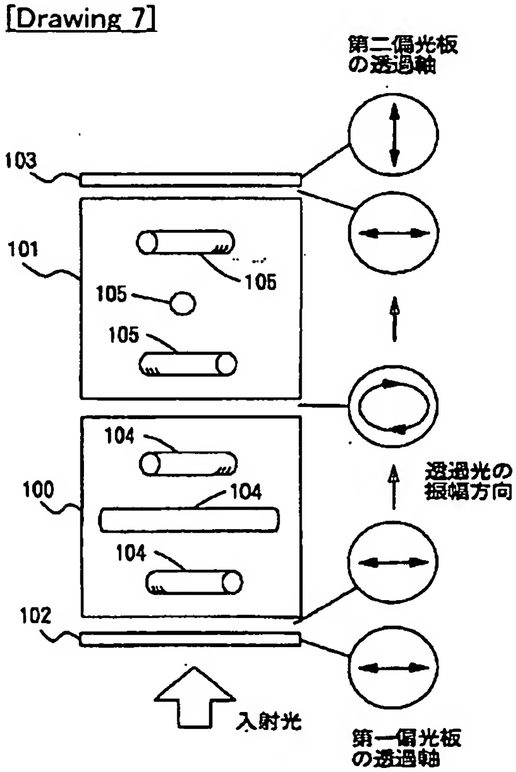
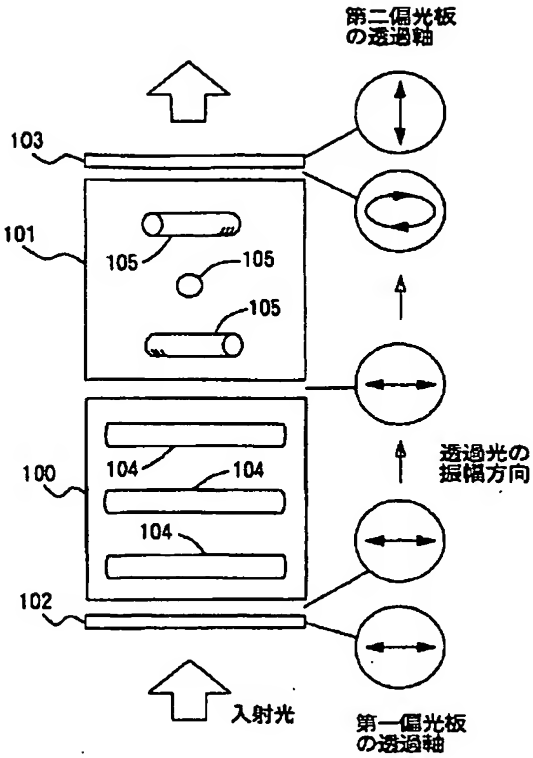
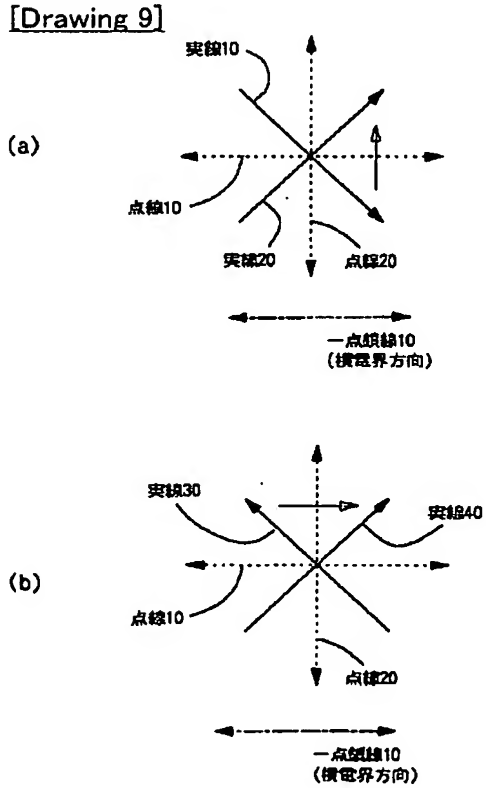


[Drawing 8]



[Drawing 9]



[Translation done.]

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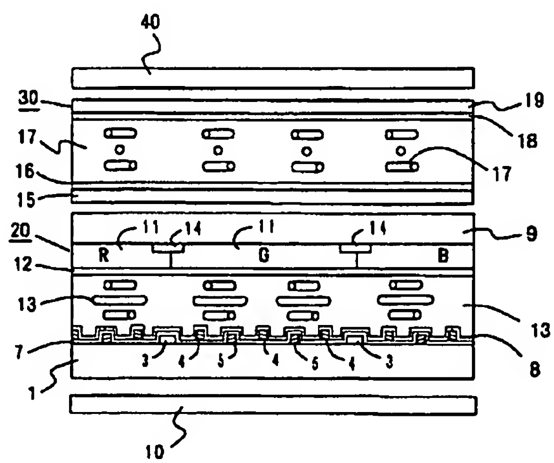
最終頁に続く

(54)【発明の名称】　液晶表示装置

(57)【要約】
【目的】　良好な黒表示が得られ、高コントラストな液晶表示装置を提供することを目的とする。
【構成】　電圧無印加時にツイスト配列し、電圧印加時に横電界が印加される液晶セル２０と、液晶セル２０に重ねられた光学補償層３０と、液晶セル２０、光学補償層の外側に配置された偏光板１０、４０を備え、液晶セル２０の法線方向から観察した場合に、横電界方向は液晶セル２０の基板１、９界面の液晶分子１３の軸方向の中間的な方向に設定され、偏光板１０、４０の透過軸はそれぞれ電圧無印加時に最も近接する液晶分子１３又は光学補償素子１７の軸方向に略平行又は略直交する方向に設定される



【特許請求の範囲】

【請求項１】　一対の基板間に液晶を封入し、該液晶が電圧無印加時にツイスト配列し且つ電圧印加時に該液晶中に発生する横電界の方向に沿って水平配列する液晶セルと、前記液晶セルに重ねて配置されると共に光学補償素子を有する光学補償層と、液晶セルの外側に配置された第一偏光板と、光学補償層の外側に配置された第二偏光板とを備え、前記液晶セルの基板の法線方向から観察した場合、電圧印加時に発生する横電界の方向は第一偏光板に最も近い液晶セル内の液晶分子の軸方向と第二基板に最も近い液晶セル内の液晶分子の軸方向との中間的な方向に設定され、第一偏光板の透過軸は電圧無印加時の第一偏光板に最も近い液晶セル内の液晶分子の軸方向に略平行又は略直交する方向に設定され、第二偏光板の透過軸は電圧無印加時の第二偏光板に最も近い光学補償層内の光学補償素子の軸方向に略平行又は略直交する方向に設定されていることを特徴とする液晶表示装置。

【請求項２】　前記光学補償層内では光学補償素子がツイスト配列すると共に、前記光学補償素子のツイスト方向が前記液晶セル内の液晶分子のツイスト方向と逆方向に設定されていることを特徴とする請求項１記載の液晶表示装置。

【請求項３】　前記液晶セルの液晶分子のツイスト角と前記光学補償層の光学補償素子のツイスト角が略等しいことを特徴とする請求項１乃至請求項２記載の液晶表示装置。

【請求項４】　前記光学補償層に最も近い液晶セル内の液晶分子の軸方向と、前記液晶に最も近い前記光学補償層内の光学補償素子の軸方向が互いに直交関係にあることを特徴とする請求項１乃至請求項３記載の液晶表示装置。

【請求項５】　液晶は正の誘電率異方性を有すると共にカイラル材が添加されていることを特徴とする請求項１乃至請求項４記載の液晶表示装置。

【請求項６】　表示モードがノーマリブラックであることを特徴とする請求項１乃至請求項５記載の液晶表示装置。

【請求項７】　前記液晶セルの一方の基板上に画素電極と共通電極が配置され、電圧印加時に前記画素電極と前記共通電極との間に横電界が発生することを特徴とする請求項１乃至請求項６記載の液晶表示装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は広視野角で高コントラストを実現した液晶表示装置に関する。

【０００２】

【従来の技術】液晶表示装置ではＴＮ方式が実用化されているが、ＴＮ方式は視野角が狭いという問題があった。そこでＩＰＳ方式やＶＡ方式などの視角特性の優れた方式が提案されている。ＩＰＳ方式の一般的な形態は、一対の基板で液晶を挟持し、一方の基板に画素電極と共通電極を配置している。画素電極と共通電極はそれぞれ櫛歯状の形状をしており、画素電極の櫛歯部分と共通電極の櫛歯部分が画素内でほぼ平行に配置されている。両基板には横電界方向の略直交方向に水平配向した配向膜が積層され、電圧無印加時は配向膜の配向方向に沿って液晶分子が水平配列する。そして電圧印加時は、画素電極と共通電極の間に発生する横電界に沿って液晶分子が回転し、この配列状態の変化によって透過率を制御している。

【０００３】ところがＩＰＳ方式には応答速度が遅いという問題があり、これを改善するために様々な改良が試みられている。その一例として特開平１０－７３８２３号公報に開示されたＩＰＳ型液晶表示装置があり、その形態を図面に基づいて説明する。なお、ここでは光学補償層を備えたノーマリブラックモードの場合を説明する。

【０００４】図７は電圧無印加時の液晶分子の配列状態を示す模式図であり、図８は電圧印加時の液晶分子の配列状態を示す模式図である。１００は液晶セル、１０１は光学補償層、１０２は入射光側の第二偏光板１０３は観察者側の第二偏光板である。液晶セル１００は一対の基板間に正の誘電率異方性を有するネマティック液晶１０４が挟持され、この液晶１０４にはカイラル材が添加されている。下側の基板には図示しない櫛歯状の画素電極と共通電極が形成され、両電極の櫛歯状部分が各画素内で平行に配置されている。上側基板及び下側基板には水平配向処理が施された配向膜が積層され、基板界面の液晶分子１０４はこの配向方向に沿って水平配列する。図９（ａ）は基板の法線方向から観察した際の配向方向と電界方向の関係を示す。一点鎖線１０は電圧印加時の電界方向、実線１０は下側基板の配向膜の配向方向、実線２０は上側基板の配向膜の配向方向、点線１０は第一偏光板１０２の透過軸、点線２０は第二偏光板１０３の透過軸をそれぞれ示す。ここで電界方向（一点鎖線１０）を０度に設定し、反時計回りを正方向、時計回りを負方向に規定したとき、下側基板の配向方向（実線１０）は－４５度、上側基板の配向方向（実線２０）は４５度に設定される。電圧無印加時には液晶分子１０４が配向膜に影響されて配列するため、下側基板界面の液晶分子１０４の長軸方向は実線１０に、上側基板界面の液晶分子１０４の長軸方向は実線２０に向いて水平配列し、液晶セル１００内では下側基板から上側基板に対して反時計回りに９０度捩れながら水平配列している。第一偏光板１０２の透過軸（点線１０）は電界方向（一点鎖線１０）と同一方向に設定され、第二偏光板１０３の透過軸（点線２０）は第一偏光板１０２の透過軸（点線１０）の直交方向に設定される。従って各透過軸は基板界面の液晶分子１０４と４５度ずれて配置されている。

【０００５】光学補償層１０１は一対の基板に補償用液

晶が挟持され、両基板にはそれぞれ水平配向処理が施された配向膜が積層されている。この配向膜の配向方向と電界印加時の電界方向の関係を図９（ｂ）に示す。実線３０は下側基板の配向方向、実線４０は上側基板の配向方向をそれぞれ示し、下側基板の配向方向（実線３０）は１３５度、上側基板の配向方向（実線４０）は４５度に設定されている。下側基板界面の液晶分子１０５はその長軸が下側基板の配向方向（実線３０）に向いて水平配列し、上側基板界面の液晶分子１０５はその長軸が上側基板の配向方向（実線４０）に向いて水平配列し、光学補償層１０１内では液晶分子１０５が下側基板から上側基板に対して時計回りに９０度捩れながら水平配列している。従って各第一偏光板１０２、１０３の透過軸（点線１０、２０）は基板界面の液晶分子１０５と４５度ずれて配置される。

【０００６】ノーマリブラックモードの場合、液晶セル１００のレタデーションを光学補償層１０１のレタデーションによって完全に相殺するように設定する。図７及び図８の右側には対応する位置における基板の法線方向から観察した際の透過光の振幅方向を示す。第一偏光板１０２を通過した透過光は０度方向に振幅する直線偏光であるが、液晶１０４により複屈折されて液晶セル１００を通過した時点では楕円偏光になる。この透過光は補償用液晶１０５によって複屈折されるが、光学補償層１０１のレタデーションは液晶セル１００のレタデーションを相殺するように設定されているため、光学補償層１０１を通過した透過光は再び０度方向に振幅する直線偏光になり、第二偏光板１０３で遮光される。

【０００７】電圧印加時は図８に示すように液晶セル１００の液晶分子１０４が電界方向（一点鎖線１０）に回転して水平配列する。このとき光学補償層１０１の補償用液晶１０５の配列状態は変わらない。ここで第一偏光板１０２を通過した直線偏光の透過光は、液晶分子１０４の長軸方向と第一偏光板１０２の透過軸方向（点線１０）が同一方向になるため、０度方向に振幅する直線偏光のまま液晶セル１００を通過する。そしてこの透過光は光学補償層１０１の補償用液晶１０５によって複屈折されて光学補償層１０１を通過したときには楕円偏光になり、第二偏光板１０３の透過軸を通過する。

【０００８】

【発明が解決しようとする課題】しかしながら上記の液晶表示装置の場合、黒表示の際に基板界面の液晶分子の軸方向と偏光板の透過軸方向が４５度ずれているため黒表示時の光漏れが生じやすく、良好な黒表示が得られ難かった。そこで特に基板界面の液晶分子の軸方向と偏光板の透過軸方向との関係について着目して研究を行った結果、良好な黒表示が得られる液晶表示装置を発明するに至った。

【０００９】つまり本発明は、良好な黒表示が行え高コントラストな液晶表示装置を提供することを目的とする。

【００１０】

【課題を解決するための手段】上記課題を解決するために本発明は、一対の基板間に液晶を封入し、該液晶が電圧無印加時にツイスト配列し且つ電圧印加時に該液晶中に発生する横電界の方向に沿って水平配列する液晶セルと、前記液晶セルに重ねて配置されると共に光学補償素子を有する光学補償層と、液晶セルの外側に配置された第一偏光板と、光学補償層の外側に配置された第二偏光板とを備え、前記液晶セルの基板の法線方向から観察した場合、電圧印加時に発生する横電界の方向は第一偏光板に最も近い液晶セル内の液晶分子の軸方向と第二基板に最も近い液晶セル内の液晶分子の軸方向との中間的な方向に設定され、第一偏光板の透過軸は電圧無印加時の第一偏光板に最も近い液晶セル内の液晶分子の軸方向に略平行又は略直交する方向に設定され、第二偏光板の透過軸は電圧無印加時の第二偏光板に最も近い光学補償層内の光学補償素子の軸方向に略平行又は略直交する方向に設定されていることを特徴とする。従って応答時間の短く、且つ良好な黒表示が得られる液晶表示装置が実現できる。

【００１１】

【発明の実施の形態】以下、本発明の実施形態を図に基づいて説明する。図１は液晶表示装置の概略断面を示し、図２は液晶表示装置の第一基板側の概略平面図を示す。この実施形態では第一偏光板１０、液晶セル２０、光学補償層３０、第二偏光板４０を順次重ねている。

【００１２】液晶セル２０では一対の基板１、９間に液晶１３が挟持されている。１はガラス基板などの透明な第一基板であり、複数の走査線２と複数の信号線３がマトリクス状に配置されている。走査線２と信号線３の交差部にはスイッチング素子であるＴＦＴ４（薄膜トランジスタ）が配置され、走査線２と信号線３で囲まれる１画素内には櫛歯状の画素電極５が配置されている。ＴＦＴ４は、ゲート電極が走査線２に、ソース電極が信号線３に、ドレイン電極が画素電極５にそれぞれ接続されている。６は複数の画素にまたがって形成された櫛歯状の共通電極であり、保護膜７上に形成されて信号線３とその交差部分で絶縁されている。各画素内では画素電極５と共通電極６の櫛歯部分が平行に配置され、画素電極５に電圧が印加されたときに画素電極５と共通電極６の間で横電界が発生する。この実施形態では、1画素内に配置される櫛歯電極の個数が画素電極５で２つ、共通電極６で３つになっているが、本発明はこの個数に限定されるものではない。８は第一基板１上に積層された配向膜であり、後述する方向に水平配向処理が施されている。

【００１３】９は第一基板１に対向配置された透明な第二基板であり、信号線２や走査線３と対向する位置に格子状の遮光膜１４が形成されている。１１は各画素に応じて配置されたカラーフィルタであり、画素毎にＲ、

Ｇ、Ｂのいずれかの着色層がストライプ状に配置されている。１２はカラーフィルタ１１上に積層された配向膜であり、後述する方向に水平配向処理が施されている。

【００１４】１３は正の誘電率異方性を有するネマティック液晶であり、カイラル材が添加されている。従って電圧無印加時には基板１、９界面の液晶分子１３は配向膜８、１２の配向方向に水平配列し、基板１、９間では捩れながら水平配列する。この実施形態では液晶分子１３の捩れ方向は、基板１、９の法線方向から観察した際に第一基板１から第二基板９の方向に対して反時計回りに回転する。

【００１５】光学補償層３０は一対の基板１５、１９間に光学補償素子である補償用液晶１７が挟持されている。１５及び１９は透明な基板であり、それぞれ後述する方向に水平配向処理が施された配向膜１６、１８が積層されている。この基板１５、１９に挟持された補償用液晶１７にはカイラル材が添加され、基板１５、１９界面の補償用液晶分子１７は配向膜１６、１８の配向方向に沿って水平配列し、基板１５、１９間の補償用液晶分子１７は捩れながら水平配列する。この捩れ方向は液晶セル２０の液晶１３と逆方向になり、基板１５、１９の法線方向から観察した際に基板１５から基板１９の方向に対して時計回りに回転する。

【００１６】液晶セル２０の第一基板１の外側には第一偏光板１０、光学補償層３０の基板１９の外側には第二偏光板４０がそれぞれ配置される。図３に各偏光板１０、４０の透過軸と液晶セル２０及び光学補償層３０の配向方向との配置関係を示す。図３は基板１９の法線方向から観測した際の透過軸方向や配向方向であり、図３（ａ）は液晶セル２０の配向方向と透過軸の関係を、図３（ｂ）は光学補償層３０の配向方向と透過軸の関係を示す。実線１は第一基板１の配向膜８の配向方向、実線２は第二基板９の配向膜１２の配向方向、点線１は第一偏光板１０の透過軸方向、点線２は第二基板９の透過軸方向、一点鎖線１は電圧印加時に生じる横電界の方向を示す。また実線３は基板１５の配向膜１６の配向方向、実線４は基板１９の配向膜１８の配向方向を示す。なお、図３では電圧印加時の電界方向（一点鎖線１）を０度方向に設定し、反時計回りを正方向、時計回りを負方向とする。

【００１７】液晶セル２０では第一基板１の配向方向（実線１）は－４５度に、第二基板９の配向方向（実線２）は４５度に設定される。電圧無印加時は基板１、９界面の液晶分子１３が配向膜８、１２の配向方向に影響されて配列するため、第一基板１界面の液晶分子１３は長軸方向が実線１と同一方向になり、第二基板９界面の液晶分子１３は長軸方向が実線２と同一方向になり、基板１、９間の液晶分子１３は第一基板１から第二基板９に対して長軸方向が実線１から実線２へ反時計回りに９０度捩れながら水平配列する。そして電圧印加時は０度

方向に電界が発生し、各液晶分子１７が０度方向に回転する。このとき基板１、９界面の液晶分子１７の捩れ方向（４５度、－４５度）に対して電界方向を中間的な方向（０度）に設定しているので、基板１、９界面の液晶分子１７はそれぞれ４５度捩れるだけでよく、応答時間が短くなる。第一偏光板１０の透過軸（点線１）は第一基板１の配向方向（実線１）と同一方向に設定され、両偏光板１０、４０の透過軸は直交している。

【００１８】光学補償層３０では基板１５の配向方向（実線３）は１３５度に、基板１９の配向方向（実線４）は４５度に設定される。そして基板１５、１９界面の補償用液晶分子１７が配向膜１６、１８の配向方向に水平配列するため、基板１５界面の補償用液晶分子１７は長軸方向が実線３と同一方向になり、基板１９界面の補償用液晶分子１７は長軸方向が実線４と同一方向になり、基板１５、１９間の液晶分子１７は基板１５から基板１９に対して長軸方向が実線３から実線４へ時計回りに９０度捩れながら水平配列する。光学補償層３０の補償用液晶分子１７が液晶セル２０の液晶分子１３の捩れ方向とは逆方向に同一角度捩れることで、液晶セル２０で旋光された透過光の偏光状態を光学補償層３０によって液晶セル２０を通過する前の状態に戻すことになる。第二偏光板４０の透過軸（点線２）は基板１９の配向方向（実線４）と同一方向に設定される。この実施形態では液晶分子１３と補償用液晶１７がそれぞれ９０度捩れ、両偏光板１０、４０の透過軸が直交するため、実線１と実線３が第一偏光板１０の透過軸（点線１）と同一方向になり、実線２と実線４が第二偏光板４０の透過軸（点線２）と同一方向になる。しかし本発明はそれぞれの偏光板１０、４０の透過軸を対向する基板１、１９界面の液晶分子の軸方向と平行又は直交方向に設定するものであり、従って少なくとも第一偏光板１０の透過軸は液晶セル２０の第一基板１の配向方向と平行方向若しくは直交方向に設定され、第二偏光板４０の透過軸は光学補償層３０の基板１９の配向方向と平行方向若しくは直交方向に設定される。

【００１９】図３では実線１と実線３、実線２と実線４がそれぞれ同一方向になるが、矢印の向きは互いに逆になっている。これは基板１、９、１５、１９界面の液晶分子１３、１７はチルト角を有して水平配列し、この矢印の向きはチルト角によって生じる液晶分子１３、１７の傾斜方向を示す。従って実線１に向いた液晶分子１３と実線３に向いた補償用液晶分子１７、実線２に向いた液晶分子１３と実線４に向いた補償用液晶分子１９はそれぞれ傾斜方向が互いに逆なる。

【００２０】この液晶表示装置の動作を図４、図５に基づいて説明する。図４は電圧無印加時の液晶分子１３などの配列状態を示す模式図、図５は電圧印加時の液晶分子１３などの配列状態を示す模式図である。なお、図４、図５ではそれぞれ右側に対応する位置における基板

の法線方向から観察した際の透過光の振幅方向を示している。

【００２１】まず図４に基づいて電圧無印加時の動作を説明する。第一偏光板１０を通過した透過光は－４５度の方向に振幅する直線偏光になる。液晶セル２０では、第一基板１界面の液晶分子１３の長軸方向（図３の実線１）が第一偏光板１０の透過軸（図３の点線１）と一致し、液晶セル２０内で液晶分子１３が反時計回りに９０度捩れるため、液晶セル２０を通過した透過光は液晶分子１３によって旋光されて４５度方向に振幅する直線偏光になる。液晶セル２０の第二基板９界面の液晶分子１３と光学補償層３０の基板１５界面の補償用液晶分子１７は互いの長軸方向（実線２と実線３）が直交するため、透過光の振幅方向は基板１５界面の補償用液晶分子１７の短軸方向と一致する。そして補償用液晶分子１７は光学補償層３０内で液晶セル２０の液晶１３と逆方向に９０度捩れるため、光学補償層３０を通過する透過光は液晶セル２０の場合とは逆方向に旋光され、第一偏光板１０を通過した透過光と同一方向に振幅する直線偏光になる。従って光学補償層３０を通過した透過光の振幅方向と第二偏光板４０の透過軸は直交するため、透過光は第二偏光板４０に遮光されて黒表示になる。

【００２２】次に図５に基づいて電圧印加時の動作を説明する。画素電極５に電圧を印加すると画素電極５と共通電極６の間に横電界が生じ、液晶セル２０の液晶分子１３は長軸が電界方向と一致するように回転して配列状態が変化する。図３に示すように電界（一点鎖線１）は０度方向に発生するため、実線１に沿った液晶分子１３は反時計回りに４５度回転し、実線２に沿った液晶分子１３は時計回りに４５度回転して、液晶セル内２０の液晶分子１３は長軸方向が０度方向になるように水平配列する。このとき基板１、９界面の液晶分子１３はそれぞれ４５度捩れるだけで、基板１、９間で９０度捩れた液晶分子１３が同一方向に向くことになり、応答時間が短くなる。電圧印加時も光学補償層３０の補償用液晶１７はその配列状態が変化しない。第一偏光板１０を通過した透過光は－４５度方向に振幅する直線偏光であるが、液晶セル２０を通過するときに液晶分子１３によって複屈折されて楕円偏光になる。さらに透過光は光学補償層３０を通過するときに補償用液晶分子１７によって複屈折され、第二偏光板４０に到達するときには第一偏光板１０を通過した元の透過光と同一方向に振幅する直線偏光ではなく、楕円偏光又は元の透過光と異なる方向に振幅する直線偏光の状態になる。従って透過光が第二偏光板４０を通過して白表示になる。

【００２３】本発明の液晶表示装置は従来例の液晶表示装置よりも黒表示時の光漏れが少なく、良好な黒表示を得ることができる。これより図６に基づいてその原理を説明する。本発明は偏光板１０、４０の透過軸と偏光板１０、４０と対向する基板１、１９の界面に位置する液晶分子１３、１７の軸方向に着目して研究を行った。旋光分散の影響を無視した場合、液晶セル２０、１００内では液晶分子１３、１０４が９０度捩れているが、これを第一偏光板１０、１０２と対向する第一基板１の界面に位置する液晶分子１３、１０４を基準にして９０度の捩れを解いたものを模式的に液晶セルとして置換できる。光学補償層３０、１０１も同様に考えて、光学補償層３０、１０１内で補償用液晶分子１７、１０５が９０度捩れているが、これを第二偏光板４０、１０３と対向する基板１９の界面に位置する補償用液晶分子１７、１０５を基準にして９０度の捩れを解いたものを模式的に光学補償層とする。このときの液晶分子１３、１７、１０４、１０５の長軸方向と偏光板１０、４０、１０２、１０３の透過軸の配置関係について、本発明の場合を図６（ａ）に、従来例の場合を図６（ｂ）に示している。本発明では液晶分子１３、１７の長軸方向と偏光板１０、４０の透過軸がそれぞれ一致するが、従来例では液晶分子１０４、１０５の長軸方向と第一偏光板１０２、１０３の透過軸が４５度ずれてしまう。従って本発明では複屈折性による光漏れは発生しないが、従来例では液晶セル１００と光学補償層１０１のレタデーションにバラツキが生じた場合に複屈折性による光漏れが発生する。製造上のバラツキなどにより液晶セル１００のレタデーションを完全に相殺するレタデーションを有する光学補償層１０１を設けることは困難であり、従来例ではこのレタデーションのバラツキに起因する光漏れを防ぐことが難しい。しかし本発明の場合は複屈折性による光漏れが発生しないので従来例よりも良好な黒表示を得ることができ、高コントラストな液晶表示装置を得ることができる。この説明では旋光分散の影響を無視したが、旋光分散の影響を考慮した場合は本発明の形態にも従来例にも旋光分散による光漏れが発生する。従って黒表示時の光漏れに本発明の場合は旋光分散が影響し、従来例では旋光分散と複屈折性が影響することになり、本発明の方が良好な黒表示が得られる。

【００２４】なお、本発明の要旨を逸脱しない範囲であれば上記実施形態以外の形態も可能である。例えば、共通電極を第二基板側に設け、画素電極と共通電極との間で斜め電界を発生させるようにしてもよい。また、この実施形態では光学補償層内の液晶分子の配列を基板に積層した配向膜の配向方向で規制したが、配向膜以外の構成によって配列方向を規制してもよい。

【００２５】

【発明の効果】本発明によれば、液晶セルの基板の法線方向から観察した場合、横電界方向は液晶セル内の両基板界面に位置する液晶分子の軸方向の中間的な方向に設定され、第一偏光板の透過軸は電圧無印加時の第一偏光板側に位置する液晶分子の軸方向に略平行又は略直交する方向に設定され、第二偏光板の透過軸は電圧無印加時の第二偏光板側に位置する光学補償素子の軸方向に略平

行又は略直交する方向に設定されているため、応答時間が短く、広視野角な液晶表示装置になる。また、光漏れの少ない良好な黒表示を得ることができ、高コントラストを実現することができる。

【図面の簡単な説明】

【図１】本発明の実施形態である液晶表示装置の電圧無印加時の断面概略図である。

【図２】本発明の実施形態である液晶表示装置の第一基板側の平面概略図である。

【図３】本発明の実施形態における液晶セル及び光学補償層の基板の配向方向と偏光板の透過軸の配置関係を示す図である。

【図４】本発明の実施形態における電圧無印加時の液晶セル及び光学補償層の動作を説明する図である。

【図５】本発明の実施形態における電圧印加時の液晶セル及び光学補償層の動作を説明する図である。

【図６】電圧無印加時の偏光板の透過軸と液晶分子の配列状態に関する本発明の実施形態と従来例の比較図である。*

*【図７】従来の液晶表示装置における電圧無印加時の液晶セル及び光学補償層の動作を説明する図である。

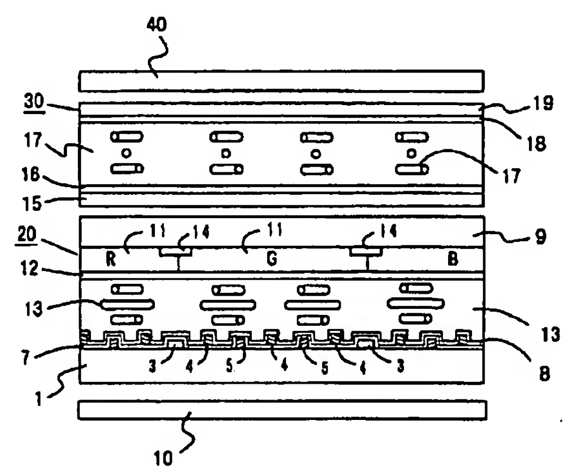
【図８】従来の液晶表示装置における電圧印加時の液晶セル及び光学補償層の動作を説明する図である。

【図９】従来の液晶表示装置における液晶セル及び光学補償層の基板の配向方向と偏光板の透過軸の配置関係を示す図である。

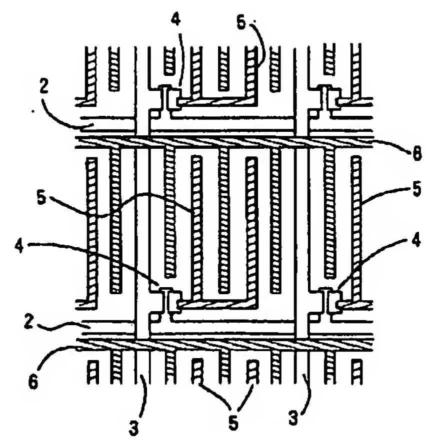
【符号の説明】

１　第一基板
８、１２、１６、１８　配向膜
９　第二基板
１０　第一偏光板
１３　液晶分子
１５、１９　基板
１７　補償用液晶分子
２０　液晶セル
３０　光学補償層
４０　第二偏光板

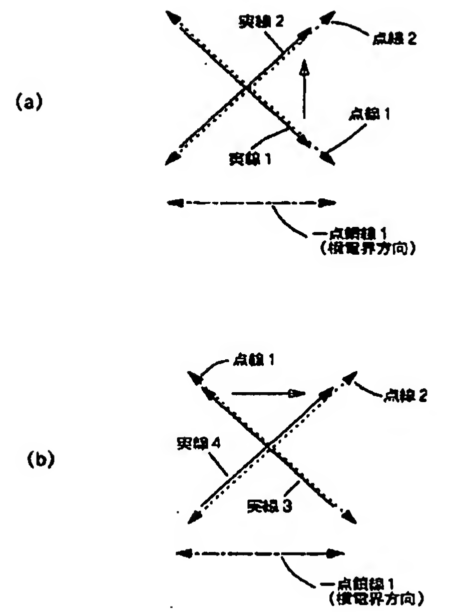
【図１】



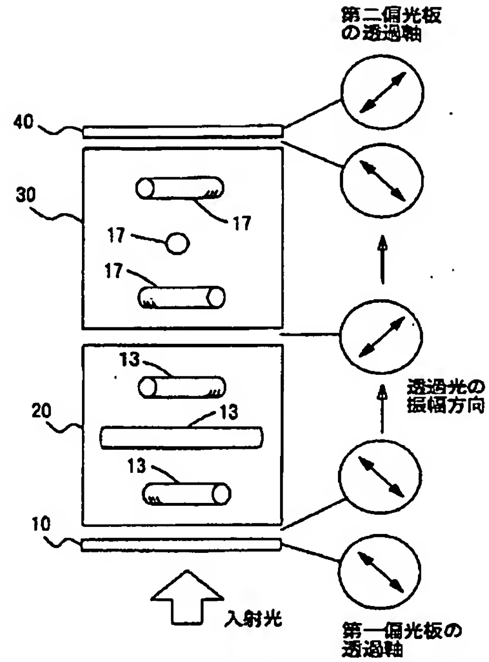
【図２】



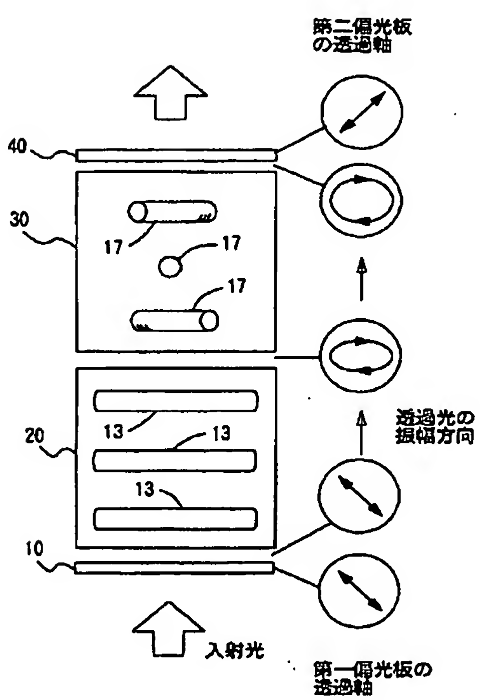
【図３】


(a)
実線２
点線２
点線１
実線１
一点鎖線１
(横電界方向)
(b)
点線１
点線２
実線４
実線３
一点鎖線１
(横電界方向)

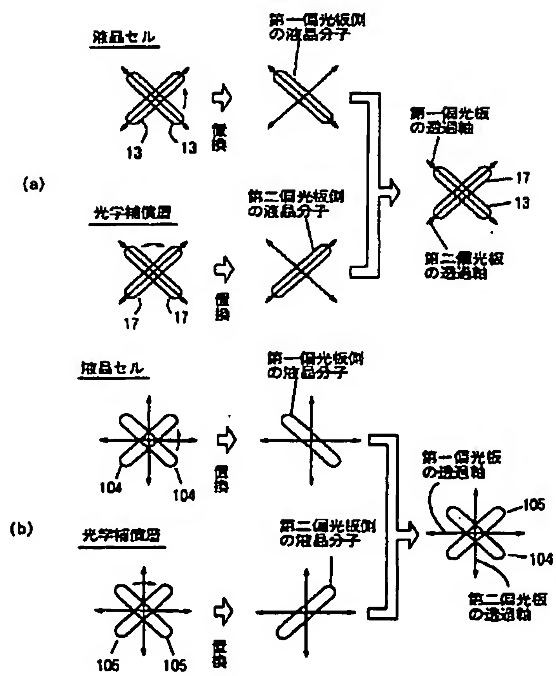
【図４】


第二偏光板
の透過軸
40
30
17
17
17
13
20
13
13
透過光の
振幅方向
10
入射光
第一偏光板の
透過軸

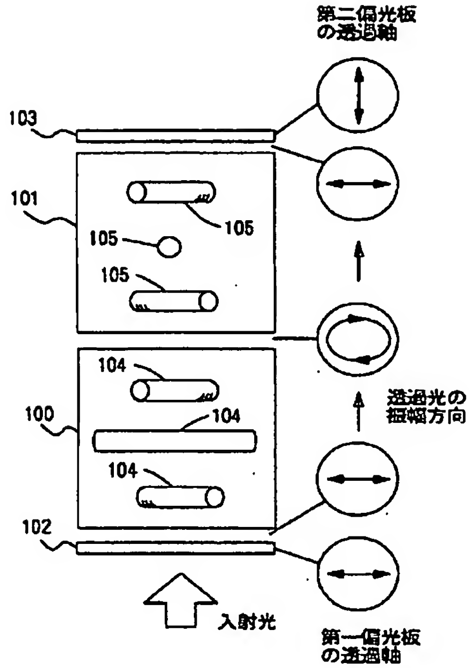
【図５】


第二偏光板
の透過軸
40
30
17
17
17
20
13
13
13
透過光の
振幅方向
10
入射光
第一偏光板の
透過軸

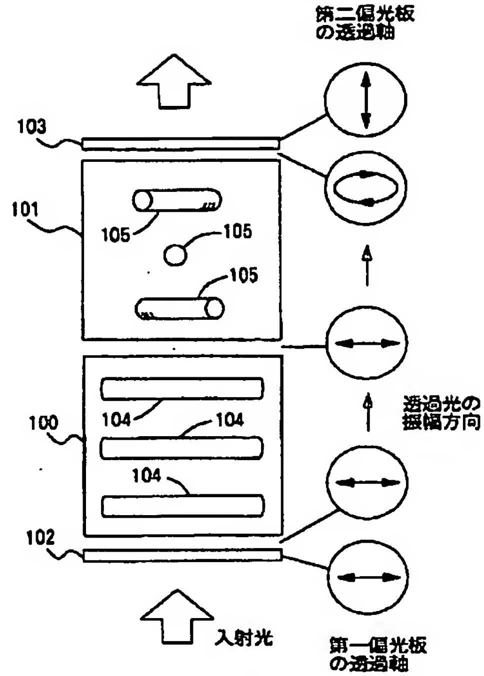
【図６】


(a)
液晶セル
13
13
置換
第一偏光板側
の液晶分子
光学補償層
17
17
置換
第二偏光板側
の液晶分子
第一偏光板
の透過軸
17
13
第二偏光板
の透過軸
(b)
液晶セル
104
104
置換
第一偏光板側
の液晶分子
光学補償層
105
105
置換
第二偏光板側
の液晶分子
第一偏光板
の透過軸
105
104
第二偏光板
の透過軸

【図７】

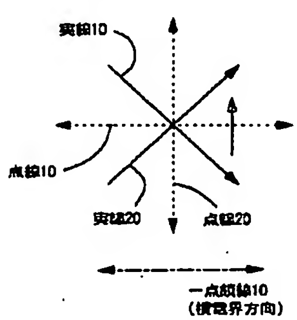

第二偏光板
の透過軸
103
101
105
105
105
100
104
104
104
102
透過光の
振幅方向
入射光
第一偏光板
の透過軸

【図８】

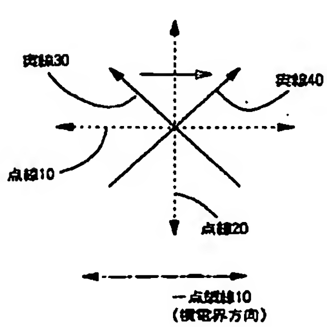

第二偏光板
の透過軸
103
101
105
105
105
100
104
104
104
102
透過光の
振幅方向
入射光
第一偏光板
の透過軸

【図９】

(a)


実線10
点線10
実線20
点線20
一点鎖線10
(横電界方向)

(b)


実線30
実線40
点線10
点線20
一点鎖線10
(横電界方向)

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